

Supplement 1: Work for Sponsors other than DOE

Part of Argonne's work is supported by sponsors other than DOE. Major sponsors include the Nuclear Regulatory Commission, Department of Defense, Environmental Protection Agency, Federal Emergency Management Agency, Department of State, National Institutes of Health, Department of Transportation, Department of Agriculture, National Science Foundation, National Aeronautics and Space Administration, Electric Power Research Institute, private firms, universities, and state governments. (See Chapter VI for program funding.)

Argonne's work for non-DOE sponsors supports accomplishment of its mission (see Chapter II) and development of its initiatives (see Chapter III). From a national perspective, this "work for others" (WFO) allows Argonne's unique facilities and capabilities to be applied to national security needs and other U.S. R&D priorities.

The Laboratory's WFO strengthens resources available for DOE missions and programs and promotes development of specific energy and environmental technologies. Furthermore, this WFO enhances Argonne's research capabilities, helps support the infrastructure at the Laboratory, and ultimately increases opportunities to transfer Argonne technologies to productive applications in the private sector. The Laboratory does not undertake work for non-DOE sponsors if that work can be performed satisfactorily by private organizations.

A. Nuclear Regulatory Commission

Argonne conducts research for the Nuclear Regulatory Commission (NRC) under a legislatively mandated memorandum of understanding between DOE and the NRC. Most of the Laboratory's work for the NRC has for many years involved supporting the Office of Nuclear Regulatory Research in its development of rules regarding plant safety and the condition of

physical components. The largest efforts have addressed materials issues, steam generator tubing degradation, high-burnup fuel, and severe-accident behavior. Recently Argonne also began to (1) enhance environmental pathway models for analyzing the transport of residual radioactive contaminants, (2) develop parameters suitable for implementing NRC rules designed to assure public health and safety at nuclear facilities during the termination of licensed operations, and (3) prepare portions of supplemental environmental impact statements for the renewal of reactor operating licenses. In addition, Argonne provides technical assistance to the Office of Nuclear Reactor Regulation and to the Office of Nuclear Materials Safety and Safeguards.

Both the research and the technical assistance performed for the NRC take advantage of the Laboratory's hot cells and its special capabilities in nuclear reactor technology, technical evaluation, systems analysis, materials science, computer code development, environmental risk modeling, and assessment of environmental and health impacts. Argonne's work helps to ensure that U.S. nuclear power plants will continue their safe and efficient production of electricity without emission of carbon dioxide.

1. Office of Nuclear Regulatory Research

Argonne's materials research focuses on the degradation of structural materials in light-water reactors caused by reactor environments, including the effects of water chemistry and neutron irradiation. These studies include measurements of (1) growth rates of stress corrosion cracks in irradiated and nonirradiated materials and (2) the fatigue life of stainless and ferritic steels used in the reactor core, piping, and pressure vessel. Results from these studies are used by the NRC to ensure the structural integrity of plants as they age. The testing includes specimens from operating commercial reactors. Additional irradiation of stainless steels performed in the Halden

test reactor in Norway and the BOR-60 reactor in Russia provides further systematic data on relationships between material composition and susceptibility to cracking after irradiation.

A comprehensive study of degradation in the steam generator tubing of nuclear power plants is under way. Critical areas being addressed include (1) evaluation of techniques used for in-service inspection of steam generator tubes and recommendations for improving the reliability and accuracy of those inspections, (2) validation and improvement of correlations and models for predicting degradation in aging tubes during operations, and (3) investigation of the potential for environmental degradation of Alloy 690, which has been used in most replacement generators in the United States. The studies focus on mill-annealed Alloy 600 tubing, but tests will also be performed on replacement materials such as thermally treated Alloy 600 and Alloy 690.

Argonne is investigating the behavior of high-burnup nuclear fuels for the NRC. To reduce operating costs and minimize the accumulation of spent fuel, nuclear utilities are striving to increase the burnup of their nuclear fuels, thus extracting more electricity from a given amount of fuel and reducing the volume of the spent fuel requiring subsequent handling, the number of refueling outages, and plant downtime. Currently, utilities seek to achieve burnup roughly 50% higher than in the 1970s, when most of the NRC's criteria and codes for fuel behavior were established. However, at high burnups, fuel pellets and cladding are potentially less resistant to damage under some conditions. These considerations may necessitate modification of (1) fuel rod damage criteria used in NRC regulations and (2) materials properties assumed in safety analyses. Furthermore, new alloys and fabrication procedures designed to counter burnup effects may also affect regulatory criteria and safety analyses. To help address these issues, Argonne is determining the behavior of high-burnup fuel under accident conditions where coolant is lost and is establishing a database for the mechanical properties of high-burnup cladding, which is needed for licensing safety analyses. The Laboratory is also investigating the way high burnup might affect cladding and the behavior of spent fuel during long-term dry storage, a strategy now being

employed at the sites of many nuclear power plants.

The NRC continues to use Argonne's broad expertise in severe-accident phenomena. The Commission was a partner in the recently completed Melt Attack and Coolability Experiment (MACE) program, which was organized by the Electric Power Research Institute. The Laboratory's contributions to this program are described in Section S1.E.1. The NRC will continue to rely on Argonne's expertise in this area through participation in the Melt Coolability and Concrete Interaction program, which is a follow-on to MACE sponsored by the Organization for Economic Cooperation and Development (see Section S1.E.5).

The NRC License Termination Rule provides assurance of public health and safety at nuclear facilities during the termination of licensed operations. To support the development of implementation guidance for the Rule and an associated Standard Review Plan, the NRC is using the Argonne software program RESRAD and has supported its expansion. The expanded program will specifically address the cleanup of contaminated sites and buildings during the decontamination and decommissioning (D&D) of facilities. The software was originally developed for DOE, to help analyze environmental remediation at DOE sites by modeling environmental pathways and the transport of residual radioactive contaminants. This NRC work included extending the existing models for probabilistic dose analyses, thereby allowing NRC licensees to demonstrate compliance with the License Termination Rule and supporting NRC evaluation of the licensees' applications for facility termination.

Argonne is initiating work on an alternative siting rule for NRC to use in evaluating new reactor sites. This rule will be used to evaluate alternatives in the early site permit and combined license applications submitted to NRC.

2. Office of Nuclear Reactor Regulation

Argonne assists the Office of Nuclear Reactor Regulation in a variety of areas related to aging and the performance of materials, components,

structures, and systems in nuclear power plants. This work helps assure that safety will be maintained as plant components age.

Argonne provides technical support to the NRC in the review of license renewal applications in areas including fatigue of metal components, thermal fatigue of cast austenitic stainless steels, irradiation-assisted stress corrosion cracking, and irradiation-induced void swelling.

Argonne participates on interlaboratory teams preparing supplemental environmental impact statements related to the renewal of nuclear plant operating licenses. These analyses have covered issues of land use, ecology, and air quality that are related to continued power plant operations.

The Laboratory is reviewing aging effects and their management for nuclear plant systems, structures, and components that must meet license renewal rules. Previous work contributed to the development of a report and associated standard review plan that serve as guidance documents for NRC reviews of license renewal applications. The Laboratory is currently updating and revising this guidance. Argonne also provides various other kinds of technical support to the Office of Nuclear Reactor Regulation.

3. Office of Nuclear Materials Safety and Safeguards

For the Office of Nuclear Materials Safety and Safeguards, Argonne is modeling environmental and health effects from uranium recovery operations to help the NRC (1) deal with changes in regulatory requirements and (2) consider revisions of existing licenses and applications for new licenses for uranium mining and processing. Enhancements of the current model will take into account *in situ* uranium leaching technology and associated processing. A key issue is the transport of uranium and decay product radionuclides (including radon gas), as well as the associated environmental and health impacts. At the same time, the Laboratory is developing an Internet-based communication mechanism to facilitate distribution of the software code and the NRC's interaction with prospective licensees. In other work, Argonne is helping to prepare an

environmental impact statement for construction and operation of a mixed-oxide fuel fabrication facility to be built at the DOE Savannah River Site. The facility will convert surplus weapons-grade plutonium into mixed-oxide fuel suitable for irradiation in light-water reactors.

B. Department of Defense

Argonne conducts research for several organizations within the Department of Defense (DOD).

1. Office of Secretary of Defense

As simulations of military operations become more accurate, the need for detailed data on terrain to support these simulations has grown dramatically. To provide the required input for the Program Analysis and Evaluation Office, Argonne is developing a sophisticated application for generation of synthetic terrain.

The Laboratory is developing components for the Joint Warfare System (JWARS), a comprehensive modeling and simulation system for analysis, planning, and acquisition. JWARS utilizes existing state-of-the-art models but adds new capabilities, including environmental effects and more comprehensive use of spatial data. An intelligent geographic information manager developed at Argonne will provide unique visualization capabilities by dynamically linking modeled data to various graphic analysis subsystems within JWARS. Argonne also assists in developing components for the Joint Warning and Reporting Network, using the Laboratory's maps and data browser system to display active, vector-based spatial data from sensors and models.

2. U.S. Air Force

The U.S. Air Force sponsors several programs at Argonne. The Laboratory's experience and expertise in conducting environmental assessments of sites with unique environmental features or unique potential impacts are being used for several major proposed Air Force activities.

Argonne is studying biodiversity at a number of Air Force installations across the country, focusing on the abundance of federal- and state-listed species and on the existence of exceptional natural communities. The information collected is incorporated into geographic information systems.

Argonne also performs studies to identify for the Air Force the most cost-effective technical approaches to environmental management. For the Air Force Materiel Command, the Laboratory is developing innovative approaches to computer-assisted management of large numbers of air pollutant emission sources in complex industrial areas. For the Air Force Center of Excellence, the Laboratory is developing approaches for assuring that Air Force actions conform to state and local air quality maintenance strategies. New approaches for environmental management will shift the emphasis from compliance to pollution prevention. In addition, the Laboratory is assisting the Pacific Air Force in its implementation of novel, cost-effective methods for carrying out environmental stewardship, including the management of cultural and natural resources at military installations in the United States and abroad.

Argonne supports a number of programs that serve Air Force Headquarters weather programs. For the Air and Space Natural Environment Executive Agent, the Laboratory evaluates technologies and procedures for the Integrated Natural Environment Authoritative Representation Program. This program generates authoritative environmental databases and models for use by the DOD modeling and simulation community. For the Air Force Combat Climatology Center, Argonne is continuing its development of the Weather Effects for the Warfighter system, an operational planning tool for assessing the impact of the environment on military systems and operations. Also for the Combat Climatology Center, the Laboratory is developing a cluster-based, mesoscale weather forecasting system for use in training and simulation. Simulated weather forecasts from this system will provide a rich training environment for staff weather officers.

As an extension of an earlier project, Argonne is customizing an enhanced version of an advanced information tool to assist the Secretary of the Air Force, Office of the Inspector General,

in handling requests made under the Freedom of Information Act.

3. The Joint Staff

Argonne supports the J-8 Directorate of the Joint Staff by evaluating emerging technologies and applying them to the mission challenges faced by the Joint community in the area of information management for modeling, simulation, and analysis. The Laboratory helps J-8 operations divisions conduct analyses more quickly and reliably by providing advanced simulation and analysis tools and methodologies. The key activities being supported include (1) validation and verification of data and models during the various phases of an analysis; (2) application of object-oriented and agent-based techniques to modeling and simulation; (3) information and knowledge management; (4) development of modeling and simulation architectures that provide interoperability among legacy models, new models, and application packages; (5) development of logistics and deployment simulations; and (6) development of designs and applications for enhancing system security and evaluating new security technologies.

Analysis of logistics and mobility has become increasingly important to the U.S. military because of continuing rapid changes in the ways that forces are deployed. The objectives are lower costs, greater transparency, and more efficient management of the relatively larger and more flexible logistic operations needed for modern warfare. Because more of the U.S. military is now stationed in the continental United States, greater importance is attached to contingency planning for deploying forces, both for missions such as disaster relief and peacekeeping and for military operations. Argonne's work on logistics and deployment modeling and simulation has focused on four areas: developing prototype models and simulations, developing novel system architectures by integrating multiple model and simulation components, conducting technology feasibility studies, and providing technical guidance regarding technologies and systems designs.

The development of modeling and simulation architectures has been a primary focus of

Argonne's work for the Joint Staff since 1987. One of the most useful results has been the Dynamic Information Architecture System, an object-oriented simulation architecture capable of easily interfacing existing models and information processing applications. One notable application is an Integrated Ocean Architecture system that supports U.S. Navy operations.

Another major Argonne object-based framework, FACET (Framework for Addressing Cooperative Extended Transactions) supports the construction of models of complex, cooperative behavior by agents. FACET can be used to implement simulation models of organizational processes, such as the complex interplay of participating individuals and organizations engaged in multiple concurrent transactions in pursuit of their respective goals. Transactions can be patterned on, for example, business practices, government and corporate policies, military standard operating procedures and doctrine, clinical guidelines, or office procedures. FACET can also incorporate other complex behaviors, such as biological life cycles or manufacturing processes.

For the Joint Staff, Argonne also participates in the development of the Complex Adaptive System model to analyze the South American cocaine trade and countervailing law enforcement strategies. In addition, Argonne has participated in the development, design, and implementation of the Analytical Network, for which the Laboratory has integrated advanced-architecture, multi-processor systems and high-performance graphical workstations into the J-8 network and has facilitated achievement of interoperability among components from multiple vendors using multiple protocols.

4. U.S. Army

Argonne (in conjunction with the Federal Emergency Management Agency) assists the Army's implementation of the Chemical Stockpile Emergency Preparedness Program (CSEPP). The Laboratory supports program development, policy analysis and development of associated guidance, emergency preparedness planning, institutional analysis, development of hazard-specific risk communications and emergency public education

mechanisms, and testing and assessment of response capabilities. Argonne also assists in technical management. This work involves hazard analysis; modeling of chemical agent dispersion; development of cost estimation and measurement methodologies; integration for emergency planning; and collection, analysis, and validation of meteorological data at each CSEPP installation.

For the Army Environmental Center, Argonne is conducting research at a series of demonstration sites to develop techniques for the environmental characterization of contaminated installations and for monitoring *in situ* remediation in the continental United States. The research focuses on developing methodologies for characterizing groundwater pathways and contaminant plume configurations that will serve as models for other installations, thereby expediting the selection of remediation technologies and the cleanup or closure of bases at many sites.

For the Waterways Experiment Station of the Army Corps of Engineers, Argonne has provided advanced visualization software to support field sampling; the Laboratory is currently a partner in the Groundwater Modeling System Program. For the Fort Worth District of the Army Corps of Engineers, the Laboratory conducts specialized environmental analyses for water resource projects.

Argonne also helps the Army Corps of Engineers implement projects under Superfund and the Defense Environmental Restoration Program through the Savannah and Kansas City Districts. For the New York and Omaha Districts, the Laboratory is developing specialized approaches to remedial investigations and feasibility studies, particularly for sites with risk of radiological contamination.

Argonne assists several districts of the Army Corps of Engineers in the efficient execution of the Formerly Utilized Sites Remedial Action Program, which was transferred from DOE to the Corps in FY1998. The Laboratory brings specialized technical capabilities to this cleanup program, including the Adaptive Sampling and Analysis Program (ASAP), the RESidual RADioactivity (RESRAD) code for dose assessment, expertise in approaches specified in the *Multi-Agency Radiation Survey and Site Investigation Manual*, multiplatform geophysical

characterization, and advanced tools for management of environmental data.

Argonne is conducting an integrated program of environmental and engineering research and technical support for the Army Corps of Engineers in the Mobile, Baltimore, and New England Districts and at the Army Environmental Center, examining issues such as land restoration, solid waste management, site characterization, detection of buried objects, and cleanup of hazardous waste sites.

For the Army Soldier and Biological Chemical Command, Argonne assists in the development and analysis of restrictions regarding the land disposal of chemical agents and their by-products in the environment. Studies are coordinated with multiple environmental agencies within the Army and with several states. The Laboratory also supports the Command's Assembled Chemical Weapons Assessment Program in the area of environmental compliance for demilitarization of assembled munitions, by exploring alternatives to incineration of material from the U.S. chemical agent stockpile. For the Chemical Demilitarization Program, Argonne investigates chemical methods for (1) analyzing agent standards and waste streams and (2) detecting heavy metals in waste streams. In addition, Argonne is employing models and analyses to address environmental management issues at the Command's Rocky Mountain Arsenal, Pueblo Depot Activity, Tooele Chemical Agent Disposal Facility, and Aberdeen Proving Ground.

Argonne provides technical assistance for environmental restoration activities at the Aberdeen Proving Ground, which has a legacy of chemical contamination. The Laboratory is seeking solutions to such problems through a restoration study at the J Field site and through sitewide remote sensing. Work addresses management of environmental information, wetlands issues, and the natural attenuation of groundwater contamination.

Argonne has undertaken studies of the environmental risks posed by active and former test ranges for the Army Developmental Test Command. The Laboratory is now conducting specific environmental restoration and compliance assessment studies at several installations of the Command

(Dugway Proving Ground, Yuma Proving Ground, and White Sands Missile Range).

Argonne supports the Army Environmental Center through R&D on environmental restoration at various Army installations, including several sites that have been placed on the National Priorities List. Specific activities include development of state-of-the-art environmental data management systems to expedite remedial decision making and use of groundwater and soil gas models to evaluate alternative methods of restoring aquifers. The Laboratory is also supporting compliance and regulatory analyses for the Center, including critical issues related to military munitions and environmental management of military ranges.

For the U.S. Army Defense Ammunition Center (USADAC), a part of the Operations Support Command (OSC), the Laboratory is developing a data system for hazardous waste characterization to support environmental compliance related to the destruction of munitions and explosives at Army installations and to the reuse and recycling of components. In related efforts, Argonne is developing a demilitarization planning and management system that incorporates the USADAC system and other information to improve the Army's ability to plan for cost-effective and environmentally sound demilitarization. In addition, the Laboratory performs specialized environmental modeling and data analyses to address radiological risk and restoration problems at OSC installations (currently the Seneca Army Depot). The Laboratory is also developing the Joint Munitions Planning System, an advanced technology simulation tool for managing the global distribution of munitions.

For the Army National Guard, Argonne provides specialized technical assistance in the analysis of issues related to the environmental management of military ranges, evaluation of the performance of cleanup remedies, innovative site characterization, and modeling of groundwater.

Argonne continues to use its Dynamic Information Architecture System to design and develop integrated modeling systems for ecosystem management by the U.S. Army. The system was applied most recently to modeling the impact of land management decisions at U.S. military installations on resident endangered species. In

particular, for the U.S. Army Engineering R&D Center, the Laboratory developed an agent-based, spatially explicit model for the red-cockaded woodpecker, a bird on the federal list of endangered species.

5. U.S. Navy

The Laboratory supports the Naval Facilities Command (NAVFAC) and the Civil Engineer Corps Officer School in the area of ecological risk assessment, in part by transferring to the Navy restoration program the ecological risk assessment methodologies developed for DOE cleanup programs and also by developing information management systems to increase the efficiency of responses to ecological risk assessments. In addition, the Laboratory provides technical leadership for NAVFAC characterization and risk assessment of depleted uranium in the environment of the Navy's China Lake facility.

6. Defense Threat Reduction Agency

As part of its R&D program in support of arms control and homeland security, Argonne develops treaty verification and threat attribution procedures and technology for the Defense Threat Reduction Agency. Currently, the Laboratory's verification programs focus on the overall long-term information and organizational requirements for verification, validation, and compliance as additional treaties are being implemented. This activity includes analysis of functional requirements, technical evaluation, independent verification, and validation for new automated systems; prototyping for automated training techniques; and assistance in implementation planning. Argonne also conducts life cycle analyses in support of strategic planning for arms control treaty software systems and performs studies and technical evaluations in support of the Open Skies Treaty. Recent additions to the homeland security component of this program include an investigation of methods for attributing a domestic nuclear threat to its perpetrators and a project to evaluate and develop biological microarrays for detecting and analyzing potential biological threats.

7. Defense Advanced Research Projects Agency

As part of the Globus project of the Defense Advanced Research Projects Agency (DARPA), Argonne researchers are developing the fundamental technologies needed to build computational grids. Grid services under investigation include scalable mechanisms for managing resources in distributed systems, an architecture for data management, and basic security algorithms. The long-term goal of the Globus project is to provide basic technology that enables new classes of applications, such as teleimmersion.

As part of the Hybrid Technology Multithreaded Computer Architecture led by the Jet Propulsion Laboratory, Argonne is completing evaluation of petaflops-scale computer architectures.

In other work for DARPA, Argonne is developing oxide thin-film technology for radar and communications systems and biological microchips (biochips) for use as sensors and detectors.

8. Joint Program Office for Special Technology Countermeasures

For the Joint Program Office for Special Technology Countermeasures, Argonne is identifying, collecting, and synthesizing data about the U.S. natural gas, petroleum fuels, and water infrastructures and is developing and applying analytical tools for isolation and system analyses. In addition, the Laboratory is examining trends in the petroleum refining industry, modeling infrastructure interdependencies as complex adaptive systems, and examining risk-based decision methodologies. The overall objective is a capability to identify susceptibilities and operational dependencies in critical infrastructure that, if not remedied, could threaten accomplishment of vital military missions.

C. Department of Health and Human Services

Funding for Argonne's work for the Department of Health and Human Services either flows through the University of Chicago or is received directly through interagency agreements with DOE. (In Chapter VI see University of Chicago Grants and Department of Health and Human Services, respectively.)

University of Chicago Grants

The National Institutes of Health (NIH) supports a broad range of fundamental studies at Argonne. These investigations often apply techniques developed in DOE-supported programs to studies in structural biology, biophysics, carcinogenesis, mutagenesis, and physiology. In turn, the Laboratory's work for NIH benefits its resources for addressing the DOE science mission, including the Department's new Genomes to Life program.

The majority of these studies emphasize structure-function relationships or mechanisms underlying biological responses. Two projects are investigating abnormal regulation of expression of the proliferating cell nuclear antigen gene in "wasted" mice. The objective is to determine whether a deletional mutation in the promoter region of the gene is responsible for the "wst" mutation and the "wasted" phenotype of mice having motor neuron degeneration, radiation sensitivity, and immunodeficiency. These studies also involve the identification and characterization of genes induced in cultured cells following exposure to DNA-damaging agents.

Biophysical studies are addressing the properties of human antibody light chains that lead to pathologic deposition in myeloma. Investigations of *in vitro* aggregation of light chains consider their structure and pathologic characteristics. One project is developing new procedures for the heterologous expression of functional membrane proteins in quantities sufficient for X-ray crystallography to determine the proteins' structures and functions. Another project is investigating the mechanisms by which

cadmium causes bone loss and is relating the findings to human exposure.

Argonne was among the initiators of the structural genomics program in the United States. NIH now is supporting a major new effort in structural genomics at the Laboratory, with an ultimate goal of determining the structures of all protein families. This effort for NIH, in partnership with the DOE-funded Structural Biology Center (SBC) at the Advanced Photon Source (APS), created the Midwest Center for Structural Genomics (MCSG). Argonne is the lead institution in the MCSG consortium, which also includes six universities. NIH will provide approximately \$5 million annually through FY 2005 to establish high-throughput methods for determining the three-dimensional structures of proteins from bacteria and higher eukaryotes. As recently as 1990, solving a single protein crystal structure could take one or more scientists several years. At Argonne, improved techniques for data collection, analysis, and structural determination now allow the structure of a protein to be solved in as little as six hours. Using X-rays from the APS, the SBC collects data of very high quality significantly faster than was possible even a few years ago. By developing (1) robotic methods to carry out tedious experimental procedures and (2) advanced computational methods for analysis of data and structure determination, Argonne has achieved huge leaps in productivity. The MCSG is continuing to develop high-throughput methods in molecular biology, protein purification, and crystallization. Combined with highly efficient SBC beamlines and automated crystallography, these methods will further accelerate the process of determining new protein structures. NIH support of the MCSG will enable further major improvements in productivity.

Interagency Agreements with DOE

The National Institutes of Health is also partnering with Argonne to construct and operate a collaborative access team (GM/CA-CAT) at the APS. This effort will parallel and cooperate with the SBC and the MCSG. Utilizing two undulators and a bending magnet, the new collaborative access team will develop three X-ray beamlines optimized for macromolecular crystallography. Office and laboratory space for staff and users

will be developed in a new office-laboratory module to be constructed at the APS. The beamlines will include high-throughput robotic sample delivery, high-speed data collection with online analysis, and remote access through interactive computer networks. Construction, begun in FY 2002, is planned in two sequential phases that will allow data collection to begin at the first beamline during construction of the other two beamlines.

Argonne provides technical support to the U.S. Public Health Service, Division of Federal Occupational Health, in the development and implementation of an environmental health and safety assessment program for the U.S. Social Security Administration. The principal objective is to develop an overall program framework, plans and protocols, and facility assessments at randomly selected facilities in ten regions. Information gathered during pilot assessments in a few regions will be used to guide subsequent work.

D. Other Federal Agencies

1. Environmental Protection Agency

Argonne applies its Dynamic Information Architecture System as the framework for ecosystem modeling and environmental health assessment through a U.S. Environmental Protection Agency (EPA) system known as MIMS (Multimedia Integrated Modeling System). MIMS allows researchers to consider the environment for nutrients and chemicals across air, water, and land.

For the EPA Office of Pollution Prevention and Toxics and EPA Region V, Argonne is extending methods of analyzing cumulative environmental risks in urban areas by enhancing the availability and performance of scientifically sound procedures, models, analytical tools, and guidelines. One objective is to identify areas within the metropolitan Chicago region where exposures of the general population to individual pollutants or combinations of pollutants might be significant.

For the EPA National Center for Environmental Assessment, Argonne is evaluating

and implementing methodologies related to assessing cumulative risks, including risk of exposures to chemical mixtures by multiple pathways. Applications to DOE sites are being demonstrated.

To calculate radionuclide slope factors useful in predicting incremental cancer risks due to exposure to low levels of radioactive materials, Argonne is assisting the EPA with documentation and implementation of revised radiation dosimetry and risk analysis methods. In addition, Argonne provides guidance documentation, training materials, and fact sheets for the EPA's *Radiation Exposure and Risk Assessment Manual*.

Argonne will assist the EPA Technology Innovation Office with its Triad Program of systematic planning, dynamic work plans, and field analytics, which aims to accelerate environmental cleanup by employing the Laboratory's experience with adaptive sampling, expedited characterizations, and brownfield sites.

For the EPA Region VIII office in Denver, the Laboratory is conducting an environmental site characterization in the Upper Silver Creek watershed near Park City, Utah. This area includes many historic mining sites and is now undergoing major urbanization and resort development. The regional hydrogeology is very complex, with overlapping contaminant sources. Argonne will apply its integrated QuickSite® approach at the watershed scale to guide and limit subsequent data collection and to produce a sound regional hydrogeologic model that will support planning and decision making for environmental cleanup.

2. Federal Emergency Management Agency

Argonne's support to the Federal Emergency Management Agency involves three major areas relating to accidental or deliberate releases of chemical, biological, and radiological materials: (1) analysis and evaluation of the capabilities of U.S. industry, nearby communities, and host states to respond to emergencies involving the materials; (2) R&D on guidance for emergency planning, exercises to test emergency plans, and response activities; and (3) the development and conduct of training activities.

3. Department of State and International Atomic Energy Agency

Throughout most of its existence, Argonne has actively supported the worldwide transfer of peaceful applications of nuclear technology. Shortly after the Laboratory was founded, the first international training activities were established as part of the Eisenhower Atoms for Peace program. Participants came from throughout the world to learn about the new, rapidly developing field of nuclear reactor technology. Today, graduates are the leaders of national programs in many countries involving the peaceful applications of nuclear technology.

In 1976, Argonne was designated by the Department of State as host institution for U.S. participation in the new Nuclear Power Training Program of the International Atomic Energy Agency (IAEA). Under this program the Laboratory develops, organizes, and conducts training courses covering a full range of topics in the peaceful applications of nuclear technology. Subject areas include nuclear power, power and research reactor safety, D&D, energy planning, nuclear electronics, isotope hydrology, and environmental monitoring. Approximately 3,000 professionals from over 100 countries, representing essentially all developing member states of the IAEA, have received intensive training through these courses.

Argonne provides technical and management support to the Department of State and directly to the IAEA. One major activity is evaluation of technical cooperation projects proposed for funding by the United States, along with monitoring and facilitation of the implementation of such projects once funded. The Laboratory developed and now maintains — by means of an electronic database — an “institutional memory” of U.S. support for technical cooperation projects, as well as extensive project files, IAEA reports, and evaluation studies. The Laboratory also supports the Department of State and the IAEA in their initiatives to improve the agency’s technical cooperation program. Argonne regularly reviews and analyzes the program’s management and achievements. The Laboratory also develops recommendations on matters of policy or practice related to U.S. support for the program. By

providing experts for technical cooperation programs, Argonne has helped many countries develop the ability to analyze the operation of their energy systems.

A new Argonne project supports the Department of State in analyzing the scientific, regulatory, and environmental aspects of technology related to sustainable development of energy and water systems.

4. Department of Transportation

For the Research and Special Projects Administration, Argonne continues to model the effects of accidents resulting from transportation of chemicals on the nation’s highways and railways. These models will address (1) the effectiveness of establishing protective distances from accidents involving spills on highways and rails and (2) chemical spills into bodies of water from highway and rail accidents. In support of regulation development, the Laboratory is involved in a national assessment of risks (especially risks through inhalation) associated with transporting toxic chemicals.

5. Department of Agriculture

As part of an ongoing program for the Commodity Credit Corporation of the U.S. Department of Agriculture (CCC/USDA), Argonne supports remediation of sites having contaminated groundwater and soil by integrating field sampling, groundwater modeling, and engineering cost analyses. The Laboratory is also developing new cone penetrometer technologies and using them — in combination with innovative sampling, analytical, and computer data processing methods — to map the subsurface distribution of contaminants in soils and groundwater at former CCC/USDA grain storage sites. In addition, Argonne is conducting pilot studies of spray irrigation as an alternative to traditional methods of treating contaminated groundwater.

Argonne is assisting in the technical development of the Research, Education, and Economics Information System (REEIS), a “data mart” that integrates multiple databases in the USDA’s

Research, Education, and Economics program by using a web-based information architecture. REEIS will improve access to information by employing a consistent, integrated framework and will provide automated tools for analyzing the information.

6. National Science Foundation

Funding for most Argonne work for the National Science Foundation (NSF) flows through universities (see Chapter VI).

Argonne is a partner in the National Computational Science Alliance, funded by the NSF Partnerships for Advanced Computational Infrastructure program. Researchers are developing software for collaborative problem solving, distributed computing technology, advanced visualization tools, and parallel input-output technology.

Argonne is one of four institutions participating in the TeraGrid project, which aims to develop the world's first multisite supercomputing system, the Distributed Terascale Facility. The TeraGrid is led by the National Center for Supercomputing Applications (NCSA) at the University of Illinois at Urbana-Champaign and by the San Diego Supercomputer Center, two leading sites of NSF's Partnerships for Advanced Computational Infrastructure. By integrating the most powerful computers, software, networks, data-access systems, and applications, the TeraGrid will create a unique national resource to support scientific breakthroughs.

As a world leader of emerging grid technologies, Argonne collaborates on several NSF-funded projects, including the Network for Earthquake Engineering Simulation project with the NCSA; the GRIDS Center project with the University of Chicago, the University of Southern California Information Sciences Institute, the University of Illinois at Urbana-Champaign, and the University of Wisconsin; and the Grid Physics Network project with more than two dozen U.S. universities.

The Laboratory participates in a joint NSF-NOAA (National Oceanic and Atmospheric Administration) project examining the importance

for coastal processes of episodic events in the Great Lakes. Argonne's roles in the five-year program include making *in situ* measurements of physical conditions within one meter of the lake bottom and determining very low concentrations of radioactive tracers in lake sediments.

Argonne is leading an NSF-sponsored program, along with Eastern Illinois University and the University of Utah, to develop a digital library collection based on atmospheric visualization. Initial work to demonstrate how visualization can improve access by the educational and research communities to data from the DOE Atmospheric Radiation Measurement Program will facilitate advances in atmospheric boundary layer physics.

7. National Aeronautics and Space Administration

For the National Aeronautics and Space Administration (NASA), Argonne is developing test beds to study applications of distributed computational grids. Argonne researchers, together with investigators at the University of Southern California's Information Sciences Institute, are also teaming with NASA researchers to implement Globus Toolkit technology on the NASA Information Power Grid.

In another project for NASA, the Laboratory is developing and applying an integrated systems approach (involving remote sensing, geochemical and ecological analyses, and hydrologic modeling) to assess, monitor, and model impacts of changes in the landscape and land cover associated with major agricultural development projects in Saharan Africa. Of particular interest are the effects of the development projects on water resources and the production of new carbon sinks. Results from the test site in southwestern Egypt will be applicable throughout the arid regions of North Africa and the Middle East. This work extends ongoing Argonne collaborations with scientists at Cairo University, the Egyptian Ministry of Irrigation and Public Works, and the Egyptian Geological Survey. The work also builds on Laboratory expertise in carbon sequestration developed in projects for DOE's Office of Biological and Environmental Research.

In addition, Argonne is building a state-of-the-art laboratory for trace element detection to study the composition of interstellar dust from supernovas and from comet tails, as well as the composition of components of the solar wind retrieved from Earth satellites. These studies will reveal secrets of the origin and evolution of the universe.

In other work for NASA, Argonne is providing technical assistance and oversight for the Plum Brook Reactor Facilities Decommissioning Project. Four Argonne staff members are serving in the areas of management of construction, quality assurance, health and safety, and radiation safety. This project is expected to continue until 2007.

8. Department of Commerce

Argonne works with two organizations within the Department of Commerce: NOAA and the National Institute of Standards and Technology (NIST).

The Laboratory is collaborating with NOAA's Great Lakes Environmental Research Laboratory and Ohio State University to develop algorithms for interpreting multispectral satellite observations of the Great Lakes. This work involves field studies of the Great Lakes' optical properties and the development of specialized radiative transfer models appropriate for the optically complex waters typical of the Great Lakes.

The NIST Advanced Technology Program (ATP) requires participating private companies to match NIST funding. The private sector can then choose to subcontract to the national laboratories in the pursuit of new technology. (See Section S1.E.2.)

9. Department of the Interior

Argonne provides technical support on environmental issues to the Bureau of Land Management (BLM) of the Department of the Interior, helping BLM maintain long-term stewardship of public lands while allowing production of resources such as oil and natural gas.

Argonne is developing atmospheric dispersion models that will evaluate the effects on regional air quality of enhanced methane production from coal beds in the Powder River Range of Wyoming. Argonne is also funded directly by DOE to support BLM energy planning in the Farmington (New Mexico) and Worland (Wyoming) field offices. These projects test new analytical tools for planning future resource development and management such as computer-generated visualizations of landscape vegetation to assist in planning strategies for controlling wild fires in the western United States.

For the Interior Department's Fish and Wildlife Service, Argonne develops environmental information and communications systems. One of the systems is being developed jointly with the Chicago Wilderness Society.

10. Central Intelligence Agency

For the Central Intelligence Agency, Argonne is investigating ways to extend the lifetime of lithium-ion batteries, in terms of both calendar life and life cycle. New electrode materials are being developed that offer improved stability and greater ability to sustain repeated charges and discharges, yet maintain reversibility.

E. Nonfederal Organizations

1. Electric Power Research Institute

Argonne conducts research for the Electric Power Research Institute (EPRI) on topics related to the risk of a severe accident at a nuclear power plant. Research for the Melt Attack and Coolability Experiment (MACE) program was particularly important. This work investigated the ability of water to quench and cool a pool of molten core debris without formation of a continuous insulating crust, thereby terminating an accident and preventing basement penetration. The investigations attracted worldwide attention because of their importance to strategies for managing accidents at existing plants and their great relevance to design decisions for future light-water reactors. These experiments were sponsored by the 15-nation Advanced

Containment Experiments program headed by EPRI, which pursued realistic understanding of the consequences of an accident involving core melting. A successor to the MACE program is now being conducted under the sponsorship of the Organization for Economic Cooperation and Development. (See discussion of the Melt Coolability and Concrete Interaction program in Section S1.E.5.)

Complementary Argonne programs for EPRI aim to resolve key safety issues through a combination of analysis and experiments. The recently developed computer code CORQUENCH, based on data from Argonne experiments, is being used to analyze accident phenomena.

Other work for EPRI includes identifying and characterizing technologies and processes for mitigating the environmental impacts of cooling water intake structures at electric power plants. Argonne also assesses the use of these technologies and processes in innovative approaches to meeting environmental regulations (e.g., integrating methods such as wetlands restoration, artificial reefs, and artificial supplementation of aquatic systems into strategies such as wetlands banking and effluent trading).

2. Private Firms

Argonne conducts research for a number of private firms, making use of its unique facilities and technical resources. Current work for private firms includes the following:

- Alyeska Pipeline Service Company: An environmental impact statement on renewal of the right-of-way for the Trans-Alaskan Pipeline System, for submittal to the BLM.
- BP Corporation: Development of selective-catalytic-reduction catalysts for treating nitrogen oxides.
- Caterpillar, Inc.: Development of nondestructive evaluation technologies for improving reliability in machining of ceramic valves for low-emission heavy-duty diesel engines.
- General Atomics: Development of a tile computer display wall.

- General Motors Electro-Motive Division: Improving the efficiency and emissions characteristics of diesel engines.

- General Motors Global Alternative Propulsion Center: For advanced vehicles and fuel propulsion systems, analysis of “well-to-wheel” energy efficiencies and emissions of greenhouse gases and criteria pollutants.

- H2Fuel, LLC: Development of a fuel processor for fuel cells that operate on natural gas or propane fuel.

- IBM: Advanced hardware; grid technologies and Access Grid collaborative systems.

- Laerdal Medical Corporation: Development of slurry ice cooling for treating cardiac patients.

- Microsoft: Porting of elements of the Access Grid Toolkit to Windows XP.

- NRG Energy, Inc.: Environmental impact analysis for a 500-kV transmission line.

- Quallion, LLC: Development of an advanced battery for implantable micro-stimulator devices for patients with strokes and Parkinson’s disease. (Funding is from the NIST ATP.)

- Solar Turbines, Inc.: Application of new nondestructive evaluation technologies to ceramic materials being developed for gas-fired turbine engines that emit less pollution and operate more efficiently.

- Superior Graphite Company: Development of nonintrusive controls for an electro-consolidation process intended to replace hot isostatic pressing in the forming of mechanical components. (Funding is from the NIST ATP.)

- Ultralife Batteries, Inc.: Development of advanced lithium battery materials. (Funding is from the NIST ATP.)

In addition to the activities administered under Argonne’s WFO program, as discussed in this Supplement 1, the Laboratory also performs work with its partners in cooperative research and development agreements (CRADAs). These activities are discussed in Supplement 2.

Argonne's work for private firms often grows out of industry-laboratory collaborative projects. A good example is the Argonne Laser Applications Laboratory, which conducts R&D to support the use of high-power lasers. A recent project with the Gas Technology Institute could revolutionize the way we obtain new oil and gas supplies. The project is investigating the use of laser energy in well drilling and well completion techniques. Other projects relate to materials processing for manufacturing, such as laser heat treatment of casting dies. Processing techniques available at the Laser Applications Laboratory include high-power beam shaping and delivery, fiber optics, surface modification, and welding. Industrial partners include automotive manufacturers and suppliers and also several small businesses. One example of benefits to private firms is a low-cost weld monitor being used in a DaimlerChrysler plant in Kokomo. This monitor has saved millions of dollars by improving weld quality. Work by the Laser Applications Laboratory generally supports Argonne's major facilities and programs, such as the APS, the Intense Pulsed Neutron Source, the fusion power program, and D&D of reactor systems. Current work focuses on applying laser ablation in D&D funded by DOE's Environmental Management Science Program.

3. Universities

Current Argonne work for universities includes the following:

- Indiana University: High-performance network connection for research and education.
- Northwestern University: Metacomputing environments for optimization; participation in the Optimization Technology Center.
- Northwestern University: Educational outreach to familiarize science teachers with environmental catalysis and to place Illinois undergraduate students in summer research participation positions at the APS.
- Penn State University: Support for the design and engineering of a cold-neutron multichopper spectrometer for neutron scattering, to be installed at the Spallation

Neutron Source at Oak Ridge National Laboratory.

- University of Chicago: Collaborate to develop a system configuration and design for a passive telepresence node for sites of the National Earthquake Engineering Simulation Grid.
- University of Chicago: Collaborate on the Grid Physics Network project in the areas of data grid and virtual data research, toolkit development, application challenge problems, and outreach.
- University of Chicago: As part of the Illinois Consortium of Accelerator Research project, provide technical support in theoretical and simulation analysis for linear colliders in the areas of ionization cooling of muon beams and advanced schemes for radio frequency photocathode electron beam guns.
- University of Illinois at Urbana-Champaign: Partnership for Advanced Computational Infrastructure program.
- University of Illinois at Urbana-Champaign: Assistance in developing middleware communication services for grid-based collaborations for the project Network for Earthquake Engineering Simulation.
- University of Wisconsin at Milwaukee: Episodic events on the coasts of the Great Lakes.

4. State Governments

For the state of Illinois, Department of Commerce and Community Affairs, Argonne is developing an advanced, high-capacity computer network (I-WIRE) linking major research centers and universities in the state. The network will enable detailed power and engineering feasibility studies, as well as development of advanced interfaces for geographically distributed applications.

Argonne is working under two programs with the Illinois Department of Commerce and Community Affairs. The first involves developing biobased "green" solvents, such as ethyl lactate from corn and methyl soyate from soybeans, for industrial applications. In the second project, the Laboratory is using its widely accepted GREET

(Greenhouse Gases, Regulated Emissions, and Energy Use in Transportation) model to estimate full fuel-cycle energy use and emissions from ethanol blends that may be used for light- and heavy-vehicle diesel propulsion.

Argonne is working with the Ohio Department of Natural Resources and DOE-Fossil Energy to develop information management and analysis tools for oil and gas operations.

For the Illinois Commerce Commission, Argonne is beginning a program to analyze the state's electric power transmission system by using a new modeling and simulation approach developed by the Laboratory to study complex adaptive systems.

In another project, the Laboratory is working with DuPage County, Illinois, to develop precollege educational materials focused on recycling.

State groundwater regulatory agencies are prominent members of the nonprofit Ground Water Protection Council, along with federal agencies and other parties interested in protecting the nation's groundwater supplies. Argonne's work for the council involves preparing environmental analyses and developing environmental information management systems, all with a focus on the relationship of energy systems to groundwater protection.

5. International Organizations and Foreign Countries

With the World Bank and countries borrowing from the Bank, Argonne is working on energy and environmental analyses addressing issues such as planning least-cost expansions for electrical generating systems, estimating marginal costs of electricity production, simulating the operation of mixed hydrothermal systems, projecting overall energy supply and demand, analyzing current and future environmental effects of energy production and consumption, estimating the potential for future pollution abatement projects and their costs, and estimating the costs and effects of greenhouse gas mitigation options. Argonne typically conducts these studies in close cooperation with experts in the borrowing countries, who

often are trained to use the analytical techniques themselves.

To advance nuclear reactor technology, international sponsors utilize Argonne's unique capability to perform severe-accident experiments with real reactor materials. The Laboratory currently works with Atomic Energy of Canada, Ltd., on an experiment to explore molten fuel-fluid interaction for the CANDU reactor. The Laboratory is conducting other accident-related research as part of the Melt Coolability and Concrete Interaction program sponsored by the Organization for Economic Cooperation and Development. The technical objectives of this multiyear program are to investigate the mechanisms by which debris cools outside the containment vessel and to address remaining uncertainties related to long-term, two-dimensional interactions between the reactor core and concrete. These objectives will be met through a series of experiments.

In other work, the Japan Nuclear Cycle Development Institute supports studies of the operational characteristics of reactor concepts, the testing needed for advanced fuels, the irradiation behavior of materials, and technology for deactivating liquid metal reactors. The Central Research Institute of the Electric Power Industry of Japan also supports studies of the irradiation behavior of structural materials. Argonne collaborates with the Korea Atomic Energy Research Institute on several aspects of nuclear reactor technology, safety research, and advanced computing applications.

With Egypt's Cairo University, Argonne is investigating the hydrologic impacts of the Tushka Canal in southwest Egypt, which will divert Nile River water currently stored behind the Aswan High Dam to Egypt's western desert in order to reclaim agricultural land. The focus is on (1) impacts to the underlying aquifer and (2) landward migration of the interface between saline water and fresh water that could result when the diversion of water upstream reduces flow in the Nile. The project involves scientists in Cairo University's Center for Environmental Hazard Mitigation. The center was developed with Argonne's aid.

The Laboratory is collaborating with scientists from Costa Rica's National University to evaluate

(1) the quality of urban and semiurban aquifers in that country's central valley, (2) potential sources of pollution, and (3) the extent of urban encroachment along the Atlantic and Pacific coastlines.

Argonne works directly with many foreign countries to provide energy and environmental analyses, along with training in the use of supporting computer models, including two Argonne models, the ENergy and Power Evaluation Program (ENPEP) and the Generation and Transmission Maximizer (GTMax).

In one case the Laboratory is working with the Turkish Electricity Generation-Transmission Company (TEAS) to evaluate development of the Turkish energy system and its environmental impacts. The country's Ministry of Energy and Natural Resources is collaborating with TEAS on this project, which is funded by the World Bank. Included in the analysis is the entire Turkish energy supply system — coal, oil, natural gas, electric power, and renewable resources — as well as all end use sectors.

At the request of DOE and the U.S. embassy in the Dominican Republic, Argonne is working with that country to evaluate its model for restructuring its electricity system.

Argonne is the operating agent for the International Energy Agency program Implementing Agreement for a Co-Operative Programme for Assessing the Impacts of High-Temperature Superconductivity on the Electric Power Sector. The Laboratory's main role is to keep member countries informed about the status of superconductivity research and its progress toward application. The implementing agreement is funded by organizations in 16 countries, including the United States.

Argonne collaborates with Mexico's Petroleos Mexicanos and Universidad Autonoma Metropolitana Unidad Iztapalapa to assess regulatory options for optimizing oil and gas production and environmental protection. Recent collaborations have focused on developing a new framework for regulating drilling wastes from oil and gas exploration and development.